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(54) Plant for mixing the constituents of a settable building material composition

(57) The plant comprises a reservoir or hopper (11*b*) for each dry constituent, e.g. sand, aggregate and cement, each feeding to a hopper (H) of a weighing apparatus (17) under control of a feed device (12, 12*a*, 13); and a mixer (22) to receive the weighed constituents from the weighing machine hopper under control of a valve (19) operated in response to recordal by the weighing apparatus of a prescribed weight of the constituents.

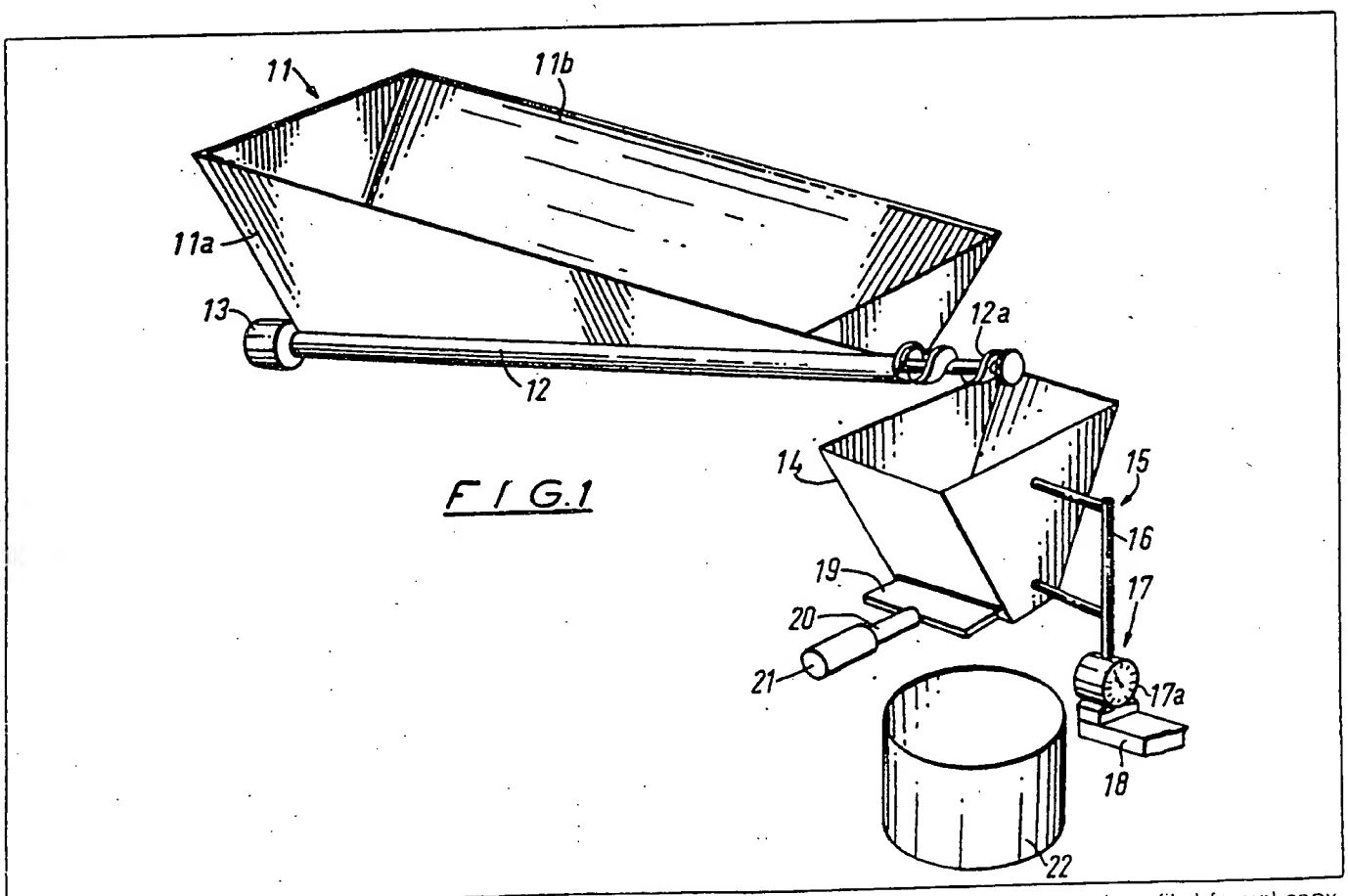


FIG.1

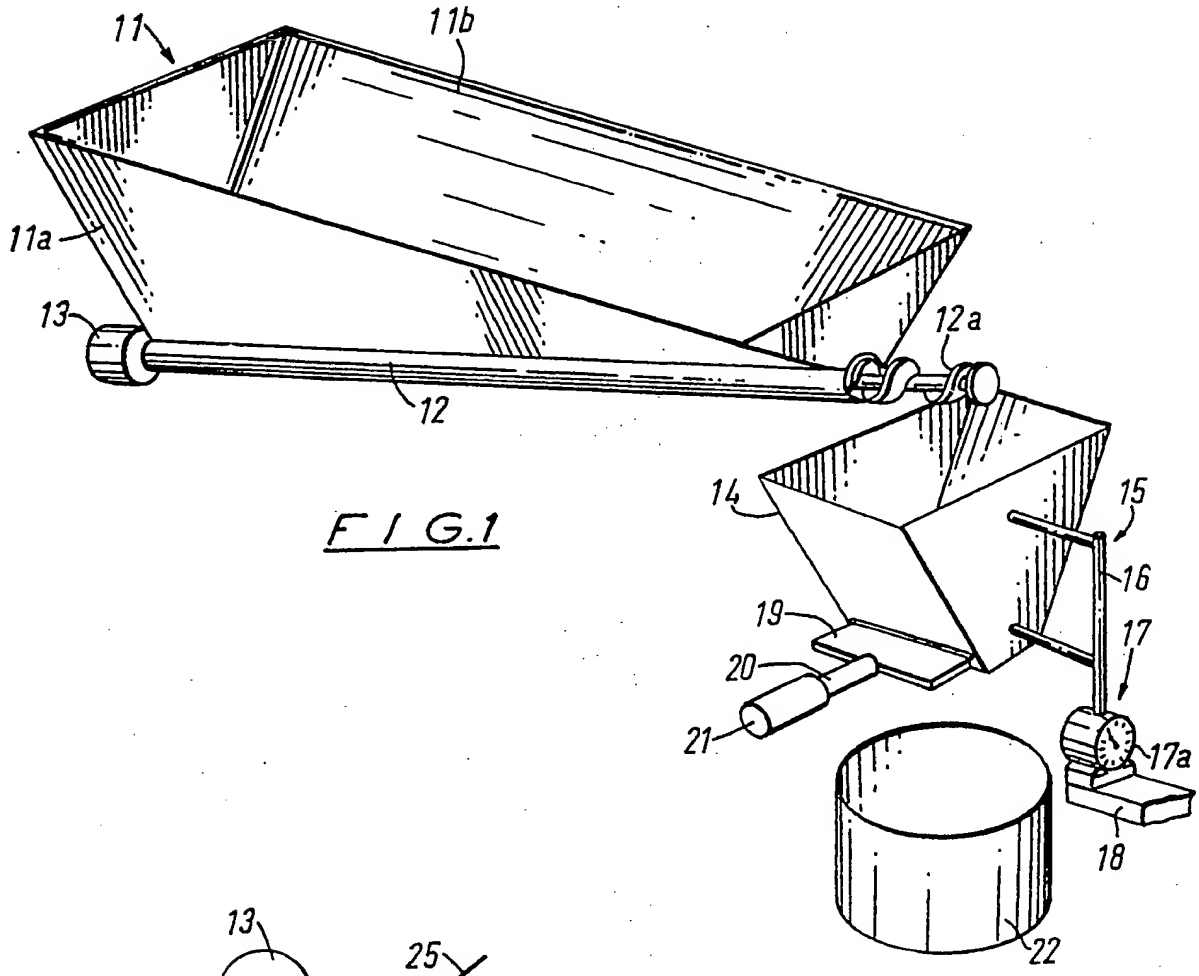


FIG.1

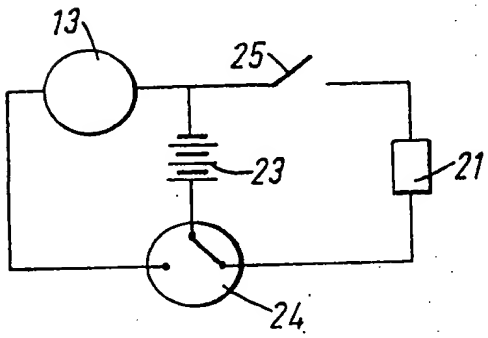
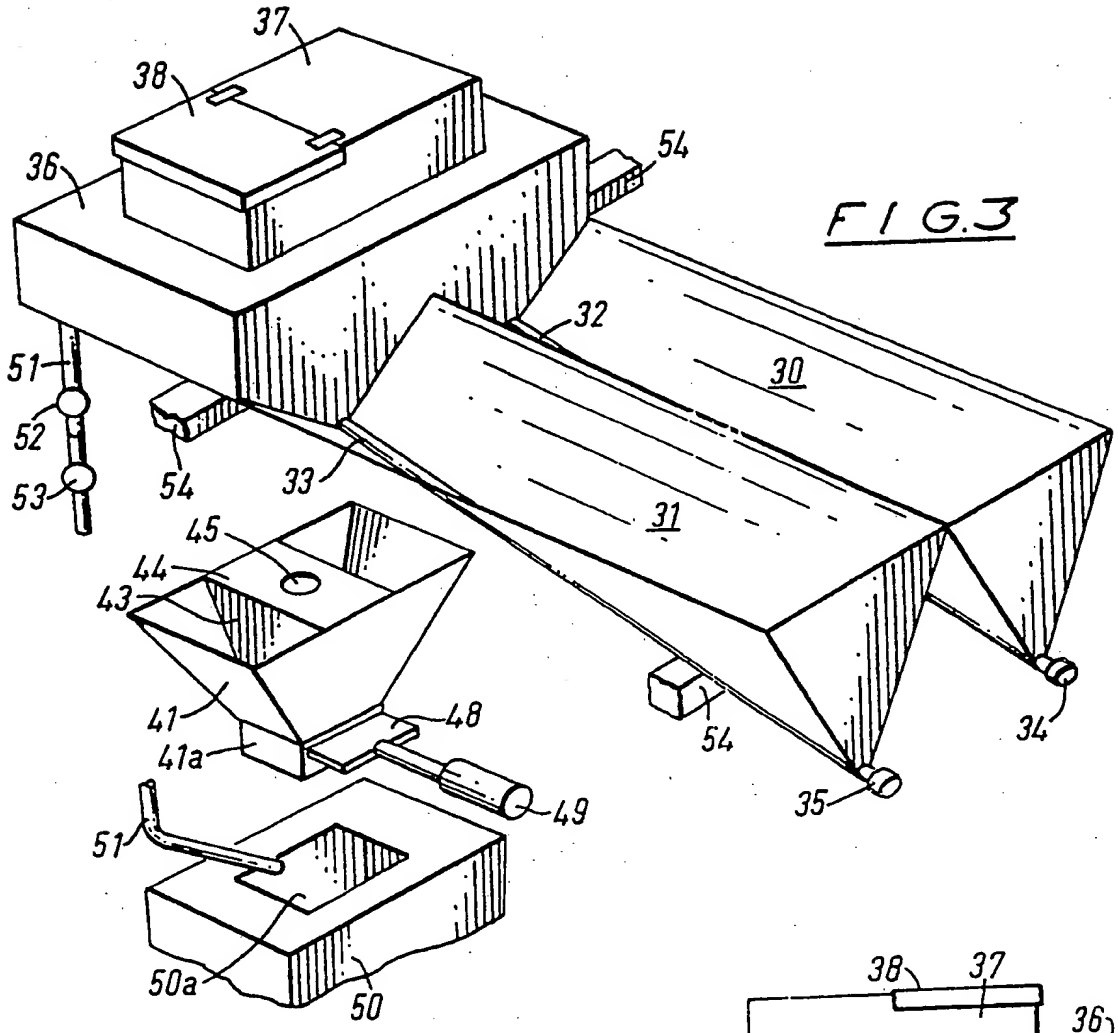


FIG.2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41a
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50a
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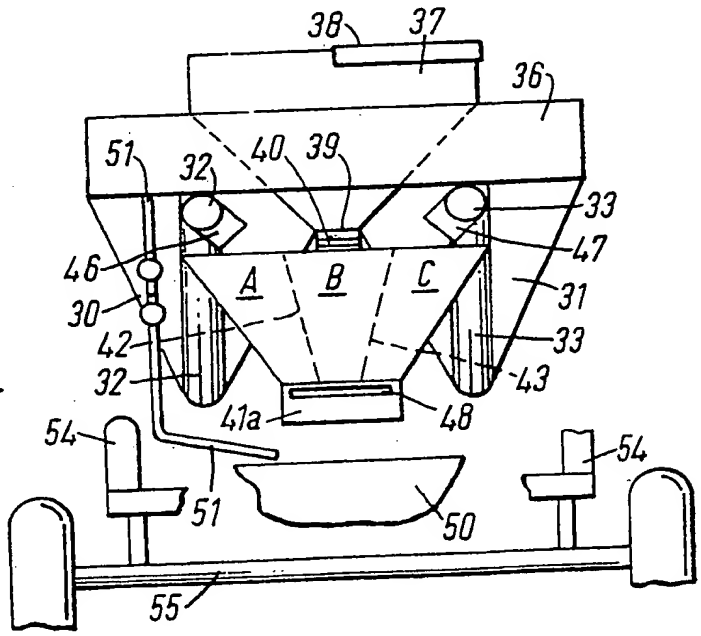
FIG.3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A
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C
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FIG.4

SPECIFICATION

Plant for mixing the constituents of settable building material compositions

This invention relates to a plant for mixing components of a settable building material composition, i.e. concrete, particularly, to a batch-type mixing plant capable of affording different mix compositions in successive batch mixings.

Batch-type mixers for concrete are well known in the art and generally comprises a cylindrical mixing chamber, open at one end to receive the batch mix and to discharge the mixed concrete therefrom, with a prime mover for rotating the mixing drum. Such mixers are conveniently charged manually using a shovel and, thereby, whilst variable mixes can be obtained this process is time taking, inaccurate, and requires considerable manual effort and mixer supervision.

In more recent times it has become the practice to deliver ready mixed concrete to site locations in specially built concrete mixing vehicles, each such vehicle being provided with a driven rotary mixing chamber which is charged with a specific batch at a supply location and rotated to "mix" the batch whilst the vehicle is travelling to a defined site location where the vehicle discharges the mixed concrete. A difficulty with this system is that the on-site volume requirement must be specified before the vehicle leaves its supply location, to ensure that the on-site demand is met it is the usual practice to over estimate the site requirement and a considerable wastage of mixed concrete results. A further difficulty with this system is that it is time taking and expensive, involving as it does the use of a specially adapted vehicle and the vehicle driver and, because of the necessity of ordering a specific mix well in advance of its requirement, the system greatly reduces the flexibility of the on-site work schedules.

The present invention seeks to provide a mixing plant capable of affording on-site batch mixing, for instance, of concrete, with facilities for varying the composition of successive batches.

According to the present invention there is provided a mixing plant for mixing the constituents of a settable building material composition, comprising a reservoir for aggregate, a weighing apparatus, a mixer, for the agregate and a settable building material, means for discharging aggregate from said reservoir to said weighing apparatus and means for discharging aggregate from said weighing apparatus to said mixer.

The plant according to the present invention may also comprise a further reservoir for any further constituent to be included in the composition, i.e. sand, and, accordingly, also comprise weighing means, means for discharging the further constituent from its reservoir to the weighing means, and means for discharging it from the weighing means to the mixer.

Preferably the plant also includes a reservoir for cement, means for discharging cement from said reservoir to weighing means, and means for discharging cement from said weighing means to said mixer.

Preferably the reservoir for aggregate and the reservoir the further constituent comprise hoppers. The reservoir for cement may also comprise a hopper.

In one embodiment in accordance with the invention, the aggregate and the further constituent are discharged to weighing means individual to each hopper, whereupon both aggregate and further constituent can be discharged simultaneously to their respective weighing means, but in another embodiment in accordance with the invention the aggregate and further constituent are discharged successively to a common weighing means, the supply of the first constituent being terminated when the weighing means indicates a predetermined weight of that constituent and the supply of the further constituent to the weighing means being terminated when the sum total of the constituents being weighed attain a predetermined weight value.

Preferably, the, or each, weighing means includes a hopper for containing the constituent or constituents to be weighed and, when the constituents for the concrete mix are to be weighed in a common hopper, the hopper may also include a chamber for cement, separated from that intended to receive the aggregate and sand, and with such an embodiment, the weighing apparatus will be charged with a first constituent up to a predetermined weight, the second constituent up to a second predetermined weight, and the third constituent up to a third predetermined weight.

When the constituents are to be weighed in a common weighing apparatus, a discharge outlet for the weighing apparatus may be located directly above the charging opening for the mixer and the means for discharging the constituents from the weighing apparatus may comprise a valve in the lower regions of the weighing apparatus whereby, when said valve is open, the weighed constituents in the weighing apparatus can flow under gravity through the open valve and into the mixer.

When the weighing apparatus discharge outlet cannot be located directly above the mixer, to allow the constituents to fall from the weighing apparatus into the mixer under gravity, or more than one weighing apparatus is provided, the means for discharging a constituent from said weighing apparatus to said mixer conveniently comprises a gravity chute or duct for directing the weighed constituent to the mixer.

In a preferred embodiment in accordance with the invention the means for discharging aggregate from the aggregate reservoir comprises a worm feed and, conveniently, the means for discharging the further constituent from its reservoir comprises a worm feed.

In a preferred embodiment, the, or each, weighing means includes a control circuit arranged to terminate the supply of the, or each, constituent to the weighing means when the weight of material in the weighing means attains a predetermined weight.

Preferably said plant is supported by a frame and, in a preferred embodiment in accordance with the invention, the frame is supported on wheels to allow the plant to traverse between on-site locations or different site locations.

Particularly in the case where a concrete is to be produced, the plant preferably includes a water reservoir to said mixer and, in a preferred embodiment, a flow meter is provided to control the volume of water supplied from the reservoir to said mixer. Thus, the plant proposed by the present invention allows accurate weight measurement of the constituents of the mix, found in practice to be superior to arrangements relying on volumetric measurements of the constituents.

The invention will now be described further by way of example with reference to the accompanying drawings in which:—

Figure 1 shows, in prespective view, one reservoir and weighing apparatus for a concrete mixing plant.

Figure 2 shows, diagrammatically, a control circuit for the arrangement shown in Fig. 1.

Figure 3 shows a perspective view of a concrete mixing plant partially in exploded view and,

Figure 4 shows, diagrammatically, an end view of the plant illustrated in Fig. 3.

In the arrangement illustrated in Fig. 1 a reservoir, in the form of a hopper 11, has a worm feed, generally indicated by reference 12, in its lower regions, the worm feed 12 being driven by a motor 13. The hopper 11 includes inclined side walls 11*a* and 11*b* at an angle greater than the maximum angle of repose for material to be contained in the hopper 11, and the lower regions of the hopper, containing the worm feed 12, slopes upwardly towards the discharge end of the worm feed 12.

Material conveyed from the hopper 11 to the discharge end 12*a* of the worm feed 12 falls, under gravity, into a weighing hopper 14 of a weighing apparatus, generally indicated by reference numeral 15, and the hopper 14 is supported by the displaceable member 16 of a weighing machine, generally indicated by reference numeral 17, supported by a fixed part of a machine frame 18. The lower regions of the hopper 14 slidably support a closure plate 19 attached to one end of the displaceable member 20 of a solenoid, generally indicated by reference numeral 21. Directly beneath the discharge outlet from the hopper 14 (defined when the closure plate 19 is withdrawn from the hopper 14) is the inlet to a mixer, generally indicated by reference numeral 22.

With the above arrangement, and with the hopper 11 charged with a constituent for concrete, power is extended to the motor 13 to cause rotation of the worm feed 12, the worm feed 12 conveys material from hopper 11 to the discharge end 12*a* of the worm feed, the material discharged from the worm feed end 12*a* falls under granity into the weighing hopper 14 whilst the closure plate 19 is closing the outlet from hopper 14, and the weight of material in the hopper 14 can be monitored by the dial 17*a* of the weighing machine 17. When the desired weight of material has been charged into the weighing hopper 14, the drive to motor 13 is terminated and the solenoid 21 is actuated to withdraw closure plate 19 from its position closing the lower regions of hopper 14 and the material charged in hopper 14 will therefore fall, under gravity, from the hopper 14 and into the mixer 22.

Fig. 2 shows a control circuit for the arrangement illustrated in Fig. 1 and whereby power from a source, generally indicated by reference numeral 23, is extended to the motor 13 for worm feed 12 when a switch 24 closes the motor circuit. Power from source 23 is also extended to the solenoid 21 when the switch 24 is opening the circuit to motor 13 and when a switch 25 is closed. The switch 24 is controlled by the weighing apparatus and said switch 24 opens the motor circuit and closes the circuit to solenoid 21, when the weighing apparatus 15 is supporting a predetermined weight of material in the hopper 14. The switch 25 is closed only when the mixing apparatus 22 has completed a batch mix and said apparatus 22 is in a position to receive a new batch charge.

Thus, in a normal order of events, and with the switch 24 closing the circuit to motor 13, the motor 13 is actuated, the worm feed 12 is effective, and material is discharged from hopper 11 to the hopper 14. As the solenoid 21 circuit is opened by the switch 24, the solenoid 21 is released and the closure plate 19 is in its position closing the lower regions of the hopper 14. When the worm feed 12 has discharged a predetermined weight of material to hopper 14 the weighing machine 17 causes the switch 24 to open the circuit to motor 13, thus terminating the drive to worm feed 12, and said switch 24 prepares the solenoid 21 for actuation. Whilst the hopper 14 is being charged with material the mixing apparatus 22 will be mixing a batch so that the switch 25 will be open and solenoid 21 will be held inoperative. When the mixing

apparatus 22 has discharged its mixed batch and is in a position to receive a new batch for mixing the switch 25 closes to complete the circuit for solenoid 21, solenoid 21 actuates to withdraw the closure plate 19, thereby to open the lower regions of hopper 14, and the charge in hopper 14 then falls under gravity through the open lower regions of said hopper 14 and into the mixing apparatus 22. When the mixing apparatus 22 has received its new charge from hopper 14, and the batch mixing is initiated, the switch 25 opens, thus to release the solenoid 21 whereupon closure plate 19 is returned to its position closing the lower regions of hopper 14, and the switch 24 is displaced to close the circuit to motor 13 to initiate a new charging of hopper 14.

The reservoir and weighing apparatus 11 to 21 illustrated in Fig. 1 and the control circuit shown in Fig. 2 can be used to supply predetermined batch weights of aggregate, sand or cement to the mixing arrangement 22 and, by varying the weight at which the switch 24 operates, the weight of material delivered per batch can be selectively varied.

A reservoir and weighing apparatus 11 to 21, identical to that illustrated in Fig. 1, with a control circuit identical to that illustrated in Fig. 2, can be provided for each of the dry constituents for concrete (aggregate, sand and cement).

A reservoir and weighing apparatus 11 to 21, identical to that illustrated in Fig. 1, with a control circuit, comprising elements 13, 21, and 23 to 25, identical to that illustrated in Fig. 2, may be provided individually for the aggregate, the sand and the cement and, where all three weighing hopper outlets cannot be directly above the charging opening for the mixer 22 gravity chutes will be provided for directing material from the outlets of the hoppers 14 to the charging opening for the mixer 22.

With such an arrangement the circuits can be linked so that the respective closure plates 19 of all the weighing hoppers 14 are withdrawn simultaneously.

By this embodiment the sand, aggregate and cement for a specific mix can be accurately weighed whilst the mixer 22 is completing a mixing operation and, when the mixer 22 is ready to receive the next charge, all three weighing hoppers 14 can discharge their contents simultaneously to the mixer 22 so that the "down" time of the mixer 22 between batch mixes is relatively short.

In an alternative arrangement the aggregate, sand and cement may be held in individual hoppers 11, each provided with a worm feed 12, and the discharge ends 12*a* of all three worm feeds 12 can discharge into a single hopper 14 of a common weighing machine 17. With this arrangement a first constituent i.e. aggregate, is discharged to the hopper 14 until the weighing machine 17 identifies the desired weight of aggregate, the supply of aggregate to hopper 14 up to the desired sum weight of aggregate and sand, and the supply of sand to the hopper 14 is then terminated and cement is supplied to the hopper 14 until the weighing machine 17 identifies the sum total weight for the batch, when the supply of cement will be terminated. Once again, this arrangement allows the preparation of a batch mix, to the correct weight ratios of aggregate, sand and cement, whilst the mixing arrangement 22 is mixing the previous batch and, immediately the mixing arrangement 22 is in a position to receive its next batch mix, the entire batch mix can be delivered to the mixing arrangement 22 from the single hopper 14, thus again reducing the "down" time of the mixer 22.

In the example illustrated in Figs. 3 and 4 two hoppers, 30 and 31, each identical with the hopper 11 of Fig. 1 with worm feeds 32 and 33 respectively driven by motors 34 and 35 respectively lie in side-by-side relationship with their lower regions sloping upwardly towards a water tank 36. The upper discharge ends of the worm feed 32 and 33 are exposed beneath the tank 36, as can be seen from Fig. 4.

A cement hopper 37 passes vertically through the tank 36 so that tank 36 surrounds the mid-regions of the hopper 37. The hopper 37 has a hinged lid 38, closing a charging opening in the upper regions of the hopper 37, and hopper 37 discharges through a discharge duct 39 beneath tank 36 and which duct 39 is closable via a plate valve 40 controlled by a solenoid (not shown).

A weighing hopper 41 is located directly beneath the tank 36 and supported by a weighing apparatus (not shown) which may be similar to the arrangement 15 illustrated in Fig. 1. The weighing hopper 41 includes two plates 42 and 43 which define three separate chambers A, B and C in side-by-side relationship. The central chamber B is closed by a top plate 44 which has a central opening 45 therethrough and the discharge duct 39 of hopper 37 passes through the opening 45 with clearance so as not to affect the vertical displacement of hopper 41.

A gravity duct 46 directs material discharged from worm feed 32 to the chamber A and a gravity duct 47 directs material discharged from worm feed 33 to the chamber C of weighing hopper 41.

The hopper 41 discharges from an outlet duct 41*a* in its lower regions, the outlet duct 41*a* is closable by a plate valve 48, controlled by a solenoid 49, and the plates 42 and 43 extend substantially to the upper surface of the plate valve 48 so that, when plate valve 48 is in its closure condition, the chambers A, B and C are substantially isolated one from the others. When the plate valve 48 is displaced to its open condition all three cham-

bers A, B and C can discharge simultaneously through the outlet duct 41*a*.

The outlet duct 41*a* is vertically aligned with the charging opening 50*a* of a concrete mixing apparatus 50 directly beneath the hopper 41 and a conduit 51 extends from the water tank 36 to the opening 50*a* of the concrete mixer 51 and includes a closure valve 52 and a metering valve 53 for metering the flow through conduit 51.

The example described above operates as follows:–

The hoppers 30 and 31 are charged with aggregate and sand respectively and the cement hopper 37 is charged with cement, the lid 38 being tightly closed after the charging of hopper 37 to protect the contained cement from the elements. During charging the power circuits to motors 34 and 35 are deactivated, so that the worm feeds 32 and 33 are static, the plate valve 40 is closing the lower regions of the cement hopper 37 and the closure valve 52 is closed so that there is no discharge of any material, or water, from the plant.

The weighing apparatus (not shown) includes three switches, each of which can be set to operate at any desired weight and the weighing apparatus is set up so that, for a specific batch composition, the first switch operates when the total weight of aggregate in the hooper 41 is the desired weight of aggregate for the batch, the second switch operates when the weight in the hopper 41 is equal to the sum total of the aggregate and sand required for the specific batch, and the third switch operates when the sum total of the aggregate, sand and cement in hopper 41 is equal to the sum total of aggregate, sand and cement required for the batch. The arrangement of a weighing apparatus to operate in the manner described above is very well known in the weighing art and no further description of the arrangement of the weighing machine is necessary.

With the weighing apparatus set up for the three predetermined weights required for a specific batch power is extended to the motor 34 to cause worm feed 32 to operate and, in operating, the worm 32 displaces aggregate from hopper 30 and discharges said aggregate via duct 46 to the chamber A of hopper 41, the circuit to motor 34 being maintained until the first switch of the weighing apparatus trips indicating the desired weight of aggregate in hopper 41. With the discharge of aggregate from hopper 30 terminated power is extended to motor 35 to cause worm feed 33 to become effective and sand is discharged from hopper 31 via duct 47 to the chamber C of the weighing hopper 41. When the second switch of the weighing apparatus trips, indicative of the desired relationship of aggregate and sand for the batch, the circuit to motor 35 is broken so that the worm feed 33 becomes inoperative, thus terminating the supply of sand from hopper 31.

At this stage the solenoid (not shown) for plate valve 40 is operated, plate valve 40 is thereby displaced to an "open" condition and cement discharges through the outlet 39 of hopper 37 into the chamber B of weighing hopper 41. The discharge of cement from hopper 37 continues until the third switch in the weighing apparatus trips, indicative of the desired sum total weight of aggregate, sand and cement for the batch, whereupon the solenoid (not shown) is de-activated and the plate valve 40 closes the discharge outlet 39 to terminate the supply of cement to the hopper 41.

It will be appreciated that, in an automatic or semi-automatic arrangement, the actuation of the first switch of the weighing apparatus can open the circuit to motor 34 and simultaneously close the circuit to motor 35 and the second switch can open the circuit to motor 35 and simultaneously activate the solenoid (not shown) to open the discharge outlet 39 so that a relatively fast charging of hopper 41 can be effected.

Further, for very accurate measurement of the constituents, the motors 34 and 35 can be two speed motors arranged to operate at high speed, to effect a rapid discharge of the respective constituent up to a predetermined weight close to the desired weight, and then at the slower speed up to the desired weight.

With the hopper 41 charged with the desired weights of aggregate, sand and cement the plate valve 41 remains in its closure condition until the mixing apparatus 50 is ready to receive the new batch when the solenoid 49 is actuated, the plate valve 48 is displaced to its open condition, and the aggregate, sand and cement in chambers A, C and B respectively are discharged simultaneously from the hopper 41 through the charging opening 50*a* in the mixing apparatus 50.

It is then only necessary to open the valve 52 to supply water to the mixing apparatus 50 (monitored by the valve 53) to supply the exact amount of water required for the mix when the mixer apparatus 50 can immediately initiate mixing of the new batch.

Immediately the hopper 41 is discharged the plate valve 48 is displaced to its closure position and the recharging of the hopper 41 for the next batch can be initiated. If the new batch is to have the same weights of constituents as the proceeding batch no adjustment of the weighing apparatus is required but if the batch is to differ from the preceding batch adjustments of the weighing apparatus are effected before motor 34 is initiated to start the next charging cycle.

As will be seen from Figs. 3 and 4 the plant is conveniently supported on a frame, generally indicated by reference numeral 54, which may be static or mounted on one or more

wheeled axles 55 to render the plant mobile and whereby the plant may be used at different on-site locations or on different site locations and the plant may be readily displaced between a charging location for the hoppers 30, 31 and 37 to the placing site for the mixed concrete.

Thus, the plant may be mounted on a vehicle including a prime mover to give the plant the mobility of a commercial vehicle or, alternatively, the plant may be mounted on a trailer adapted to be towed between different locations by a towing vehicle. In a further embodiment the plant may be mounted on wheeled axles with a relatively small prime mover intended to allow the mobile plant to be displaced in step-by-step fashion, or at a slow continuous speed, and whereby the apparatus can traverse along a trench to continuously mix a footing to be placed in the trench.

Whilst the present invention has been described by way of example many modifications and variations will be apparent to persons skilled in the art.

In this connection, a plant according to the present invention may be used for mixing asphalt, that is, a tar and aggregate composition although it will be understood that, in this case, heating means will be needed to render and maintain the tar liquid.

CLAIMS

1. A plant for mixing the constituents of a settable building material composition, comprising a reservoir for aggregate, a weighing apparatus, a mixer for the aggregate and a settable building material, means for discharging aggregate from the reservoir to the weighing apparatus and means for discharging aggregate from the weighing apparatus to the mixer.

2. Mixing plant according to claim 1, wherein the plant includes a further reservoir for a further constituent to be included in the composition, weighing means and means for discharging the further constituent from its reservoir to said weighing means and means for discharging it from said weighing means to the mixer.

3. Mixing plant according to claim 1 or claim 2 for mixing concrete, wherein the plant includes a reservoir for cement, weighing means, means for discharging cement from that reservoir to said weighing means and means for discharging cement from said weighing means to the mixer.

4. A mixing plant according to any of the preceding claims, wherein the reservoir for the aggregate and said further reservoir, if provided, each comprise a hopper.

5. A mixing plant according to claim 4 as dependent upon claim 3, wherein the reservoir for the cement comprises a hopper.

6. A mixing plant according to claim 2 or any of claims 3 to 5 as dependent thereon, wherein the plant comprises separate weighing means for the aggregate and the further constituent respectively so that the aggregate and the further constituent can be discharged simultaneously to the mixer.

7. A mixing plant according to claim 2 or any of claims 3 to 5 as dependent thereon, wherein the plant comprises a common weighing means for weighing both the aggregate and the further constituent whereby the aggregate and the further constituent are weighed in succession.

8. A mixing plant according to claim 7, wherein the plant is arranged to terminate the supply to the weighing means of the constituent first to be weighed when the weighing means indicates a predetermined weight of that constituent, and to terminate the supply to the weighing means of the second constituent when the sum total of the constituents being weighed attains a predetermined weight value.

9. A mixing plant according to any of the preceding claims, wherein the or each weighing means includes a hopper for containing the constituent or constituents to be weighed.

10. A mixing plant according to claim 9 as dependent upon claim 7, for mixing concrete, wherein the weighing apparatus comprises a common hopper for the aggregate, the further constituent and the cement.

11. A mixing plant according to claim 10, wherein the common hopper comprises a chamber to contain the cement and to keep it separate from the aggregate and the further constituent.

12. A mixing plant according to claim 11, comprising common weighing means for all the constituents; and wherein the plant is arranged to charge the weighing apparatus with a first of the constituents up to a predetermined weight, with a second of the constituents up to a second predetermined weight and with the third constituent up to a third predetermined weight.

13. A mixing plant according to claim 7 or any of claims 8 to 12 as dependent thereon, wherein the weighing apparatus comprises a discharge outlet located directly above a charging opening of the mixer.

14. A mixing plant according to claim 7 or any of preceding claims 8 to 13 as dependent thereon, wherein the means for discharging the constituents from the weighing apparatus comprises a valve located so that, when the valve is open, the weighed constituents in the weighing apparatus can flow under gravity through the open valve and into the mixer.

15. A mixing plant according to claim 7 or any of preceding claims 8 to 14 as dependent thereon, wherein the means for discharging a constituent from the weighing apparatus to the mixer comprises a gravity shute or duct for directing the weighed constituents to the mixer.

16. A mixing plant according to any of the preceding claims, wherein the means for discharging aggregate from the aggregate reservoir comprises a worm feed.

17. A mixing plant according to claim 2 or any of claims 3 to 16 as dependent thereon, wherein the means for discharging the further constituent from its reservoir comprises a worm feed.

18. A mixing plant according to any of the preceding claims, wherein the or each weighing means includes a control circuit arranged to terminate the supply of the or each constituent to the weighing means when the weight of material in the weighing means attains a predetermined weight.

19. A mixing plant according to any of the preceding claims, wherein the plant comprises a support frame.

20. A mixing plant according to claim 19, wherein the supporting frame is itself supported on wheels to allow the plant to traverse between on-site locations or different site locations.

21. A mixing plant according to any of the preceding claims, wherein the plant includes a water reservoir with a conduit for ducting water from the reservoir to the mixer.

22. A mixing plant according to claim 21, wherein a flow meter is provided to control the volume of water supplied from the reservoir to the mixer.

23. A plant for mixing the constituents of a settable building material composition substantially as hereinbefore described with reference to Figs. 1 and 2 or to Fig. 3 or to Fig. 4 of the accompanying drawings.

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